Patent Claims

1. Retardation arrangement for converting an input radiation beam, incident from an input side of the retardation arrangement, into an output radiation beam which has over its cross section a spatial distribution of polarization states which can be influenced by the retardation arrangement and differs from the spatial distribution of polarization states of the input radiation, wherein the retardation arrangement is designed as a reflective retardation arrangement, and a useful cross section of the retardation arrangement has a multiplicity of retardation zones with a different retardation effect.

2. Retardation arrangement according to Claim 1, which comprises at least one transparent birefringent transmission element and a mirror with a reflecting surface which is arranged at a side of the transmission element situated opposite the entrance side of the retardation arrangement in such a way that after a first passage through the transmission element the input radiation is retroreflected for a second passage through the transmission element.

3. Retardation arrangement according to Claim 2, wherein the reflecting surface is arranged directly at an exit side of the transmission element which is situated opposite the entrance side of the retardation arrangement.

4. Retardation arrangement according to Claim 2, wherein a spacing exists between an exit surface of the transmission element and the reflecting surface.

5. Retardation arrangement according to Claim 2, wherein the mirror is a concave mirror.

6. Retardation arrangement according to Claim 5, wherein the transmission element has a curved shape adapted to the concave mirror.

7. Retardation arrangement according to Claim 2, wherein the reflective properties of the reflecting surface are designed such that a reflectivity and/or a phase-retarding effect are substantially equal for radiation polarized perpendicular and parallel to a plane of incidence.

8. Retardation arrangement according to Claim 2, wherein a retardation effect of the mirror is adapted to retardation properties of the transmission element in such a way that it is possible to achieve overall the desired retardation effect varying as a function of location.

9. Retardation arrangement according to Claim 2, wherein the birefringent transmission element has a multiplicity of retardation zones arranged next to one another and made from transparent birefringent material, each of the retardation zones having an axial thickness and a main crystallographic axis situated at a specific angle of inclination to a transirradiation direction, the axial thickness and the angle of inclination being designed to generate a prescribable path difference between the field components, aligned perpendicular to one another, of the radiation in the case of two-fold passage through the retardation element.

10. Retardation arrangement according to Claim 9, wherein the main crystallographic axes of the retardation zones are aligned in different directions that are perpendicular to an optical axis of the retardation arrangement.

11. Retardation arrangement according to Claim 2, wherein at least one birefringent transmission element is provided that has a main crystallographic axis and an axial thickness, a useful cross section of the retardation arrangement being divided into a multiplicity of retardation zones which are designed such that the transit direction of the radiation through the birefringent transmission element in the retardation zone runs obliquely to the direction of the main crystallographic axis of the retardation zone in such a way that the transit direction encloses with the main crystallographic axis an angle of inclination of more than 0° and less than 90° and lies in a transit plane defined by the transit direction and the direction of the main crystallographic axis, the axial thickness and the angle of inclination being adapted to one another for at least the one retardation zone in such a way that an optical path length difference of the field components in the retardation zone after two-fold passage through the retardation element corresponds to a prescribed path difference, and the orientation of the transit plane is set for each retardation zone so as to produce the preferred polarization direction desired locally for the retardation zone.

12. Retardation arrangement according to Claim 11, in which a birefringent transmission element is provided with a main crystallographic axis which is substantially parallel to an optical axis of the retardation device, and the birefringent transmission element is assigned for each retardation zone at least one deflecting structure which deflects the input radiation such that the latter penetrates the retardation zone with the angle of inclination and the direction of inclination provided for the retardation zone.

13. Retardation arrangement according to Claim 12, wherein deflecting structures for deflecting the incident radiation into the oblique transit direction are provided on an input side of the birefringent transmission element, and assigned deflecting structures for cancelling the deflection are provided on the exit side of the birefringent transmission element.

14. Retardation arrangement according to Claim 12, wherein the birefringent transmission element is formed by a plate made from birefringent material, the deflecting structures being formed directly on an entrance side and/or an exit side of the plate.

15. Retardation arrangement according to Claim 12, wherein at least one deflecting structure is a diffracting structure.

16. Retardation arrangement according to Claim 12, wherein at least one deflecting structure is a refracting structure.

17. Retardation arrangement according to Claim 12, wherein at least one deflecting structure is a diffracting and refracting structure.

18. Retardation arrangement according to Claim 12, wherein a useful cross section of the retardation arrangement is divided into a multiplicity of retardation zones with constant deflection and/or an equal angle of inclination, which fill up the useful cross section of the retardation arrangement substantially without gaps.

19. Retardation arrangement according to Claim 11, wherein a plurality of birefringent transmission elements are arranged in a useful cross section, each of the transmission elements forming a retardation zone

and having an axial thickness, [lacuna] wherein for each of the birefringent transmission elements the main crystallographic axis is tilted obliquely to the transit direction of the radiation in such a way that the main crystallographic axis and the transit direction span the transit plane, and the main crystallographic axes of at least two of the transmission elements are aligned differently.

20. Retardation arrangement according to Claim 1 which is designed for converting incoming, substantially circularly polarized radiation into outgoing, partially linearly polarized radiation.

21. Retardation arrangement according to Claim 1 which is designed in such a way that the output radiation beam is substantially tangentially or radially polarized.

22. Retardation arrangement according to Claim 11, wherein the predetermined path difference in the two-fold passage corresponds substantially to a quarter of the wavelength of the incoming radiation.

23. Retardation arrangement according to Claim 1, which is designed for converting incoming radiation, linearly polarized in one direction over an entire cross section, into outgoing, partially linearly polarized radiation which is polarized tangentially or radially.

24. Retardation arrangement according to Claim 11, wherein the predetermined path difference in the two-fold passage corresponds substantially to half a wavelength of the incoming radiation.

25. Retardation arrangement according to Claim 2, wherein the transmission element has an axial thickness of more than 100μm.

26. Retardation arrangement according to Claim 1, wherein the retardation zones have a polygonal shape.

27. Retardation arrangement according to Claim 1, wherein a useful cross section is divided into small retardation zones of the same size and/or shape.

28. Retardation arrangement according to Claim 1, wherein a number of the retardation zones are of the order of magnitude of 10 or 100 or above.

29. Retardation arrangement according to Claim 1 having a substrate and a reflective coating arranged on the substrate, wherein the reflective coating has a locally varying, polarization-varying reflective effect for the purpose of forming retardation zones with a different retardation effect.

30. Retardation arrangement according to Claim 29, wherein the reflective coating is configured as anisotropic reflective coating with a spatial variation in the anisotropy of the reflective coating.

31. Retardation arrangement according to Claim 1, wherein a spatial distribution of the retardation effect is designed such that an effective retardation distribution results which is substantially rotationally symmetrical relative to an optical axis of the retardation arrangement.

32. Retardation arrangement according to Claim 1, wherein a spatial distribution of the retardation effect is designed such that an effective retardation distribution results which has an increasing or decreasing retardation effect in a radial direction of the retardation arrangement.

33. Retardation arrangement according to Claim 1, wherein a spatial distribution of the retardation effect is designed such that an effective retardation distribution results which is non-rotationally symmetrical.

34. Retardation arrangement according to Claim 33, wherein the non-rotationally symmetrical retardation distribution has a multiple symmetry with reference to an optical axis of the retardation arrangement.

35. Retardation arrangement according to Claim 1, wherein the retardation arrangement has a substrate and a reflective coating which is applied to the substrate, which is effective for radiation from the extreme ultraviolet (EUV) region, and which has a locally different polarization-varying reflective effect for the purpose of forming retardation zones with a different retardation effect.

36. Retardation arrangement according to Claim 35, wherein the reflective coating is designed as a multilayer reflective coating having layers, lying one above another, with alternatingly high-index and low-index materials, diffractive structural elements of structures running next to one another at a spacing being provided, the spacing being smaller than the wavelength of the radiation, and an arrangement of the structures for forming retardation zones with a different retardation effect varying locally.

37. Microlithography projection exposure machine having an illuminating device, comprising a radiation source, for illuminating a mask, and having a projection objective, arranged downstream of the illuminating device, for projecting a pattern, provided by the mask, into an image plane of the projection objective, the projection exposure machine having at least one retardation arrangement for converting an

input radiation beam, incident from an input side of the retardation arrangement, into an output radiation beam which has over its cross section a spatial distribution, which can be influenced by the retardation arrangement, of polarization states which differs from the spatial distribution of polarization states of the input radiation, the retardation arrangement being designed as a reflective retardation arrangement, and a useful cross section of the retardation arrangement having a multiplicity of retardation zones with a different retardation effect.

38. Projection exposure machine according to Claim 37, wherein the retardation arrangement is designed as a deflecting mirror and is arranged between the radiation source and the mask in the illuminating device.

39. Projection exposure machine according to Claim 37, wherein the retardation device is arranged behind a last polarizing optical element in the direction of radiation flow.

40. Projection exposure machine according to Claim 37, wherein the projection objective is a catadioptric projection objective in the case of which at least one catadioptric objective part with a concave mirror and a beam reflecting device is arranged between the object plane and the image plane, the concave mirror being designed as a reflective retardation arrangement, and a useful cross section of the concave mirror having a multiplicity of retardation zones with a different retardation effect.

41. Projection exposure machine according to Claim 40, wherein the retardation arrangement comprises at least one transparent birefringent transmission element and a mirror with a reflecting surface which is arranged at a side of the transmission element situated opposite the entrance side of the retardation arrangement in such a

way that after a first passage through the transmission element the input radiation beam is retroreflected for a second passage through the transmission element, the birefringent transmission element having a multiplicity of retardation zones arranged next to one another and made from transparent birefringent material, each of the retardation zones having an axial thickness and a main crystallographic axis situated at a specific angle of inclination to a transirradiation direction, the axial thickness and the angle of inclination being designed to generate a prescribable path difference between the field components, aligned perpendicular to one another, of the radiation in the case of two-fold passage through the retardation element.

42. Projection exposure machine according to Claim 41, wherein the main crystallographic axes of the retardation zones are aligned in different directions that are perpendicular to an optical axis of the retardation arrangement.

43. Projection exposure machine according to Claim 41, wherein at least one birefringent transmission element is provided that has a main crystallographic axis and an axial thickness, a useful cross section of the retardation arrangement being divided into a multiplicity of retardation zones which are designed such that the transit direction of the radiation through the birefringent transmission element in the retardation zone runs obliquely to the direction of the main crystallographic axis of the retardation zone in such a way that the transit direction encloses with the main crystallographic axis an angle of inclination of more than 0° and less than 90° and lies in a transit plane defined by the transit direction and the direction of the main crystallographic axis, the axial thickness and the angle of inclination being adapted to one another for at least one retardation zone in such a way that an optical path length difference of the field

components in the retardation zone after two-fold passage through the retardation element corresponds to a prescribed path difference, and the orientation of the transit plane is set for each retardation zone so as to produce the preferred polarization direction desired locally for the retardation zone.

44. Projection exposure machine according to Claim 41, wherein a birefringent transmission element is provided with a main crystallographic axis which is substantially parallel to an optical axis of the retardation device, and the birefringent transmission element is assigned for each retardation zone at least one deflecting structure which deflects the input radiation such that the latter penetrates the retardation zone with the angle of inclination and the direction of inclination provided for the retardation zone.

45. Projection exposure machine according to Claim 37, wherein the projection objective is a catadioptric projection objective in the case of which at least one flat deflecting mirror is arranged between the object plane and the image plane, the deflecting mirror being designed as a reflective retardation arrangement, and a useful cross section of the deflecting mirror having a multiplicity of retardation zones with a different retardation effect.

46. Projection exposure machine having an illuminating device, comprising a radiation source for extreme ultraviolet radiation (EUV) for illuminating a reflective mask, and having a projection objective, arranged downstream of the illuminating device, for projecting a pattern, provided by the mask, into an image plane of the projection objective, the projection exposure machine having at least one retardation arrangement for converting an input radiation beam, incident from an input side of the retardation

arrangement, into an output radiation beam which has over its cross section a spatial distribution, which can be influenced by the retardation arrangement, of polarization states which differs from the spatial distribution of polarization states of the input radiation, the retardation arrangement being designed as a reflective retardation arrangement, and a useful cross section of the retardation arrangement having a multiplicity of retardation zones with a different retardation effect.

47. Projection exposure machine according to Claim 46, wherein the retardation arrangement has a substrate and a reflective coating which is applied to the substrate, which is effective for radiation from the extreme ultraviolet (EUV) region, and which has a locally different polarization-varying reflective effect for the purpose of forming retardation zones with a different retardation effect.

48. Projection exposure machine according to Claim 47, wherein the reflective coating is designed as a multilayer reflective coating having layers, lying one above another, with alternatingly high-index and low-index materials, diffractive structural elements of structures running next to one another at a spacing being provided, the spacing being smaller than the wavelength of the radiation, and there being a locally varying arrangement of the structures for forming retardation zones with a different retardation effect.